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Method for configuring electrolytic cells and electrical storage batteries and cells and batteries obtained using this method

SOÇIÉTÉ DES ACCUMULATEURS FIXES ET DE TRACTION
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The specific purpose of this invention is a method for configuring the electrical connections of electrodes in electrolytic cells and electrical storage batteries and their connection to the current output terminals. Another purpose of the invention is the electrolytic cells and storage batteries themselves obtained by application of this process.

A storage battery or electrolytic cell obviously has at least two electrodes, one negative and the other positive, with an electrolyte between them. This electrolyte continuously impregnates, or bathes a porous electric insulator that comprises the separator. The well-known role of the electrolyte is to transport ions from one electrode to the other, thus enabling electrochemical reactions that generate electric current.

For reasons of dimension and efficiency, electrodes and their separators must be thin. Moreover, the electrical energy that can be supplied by these elements depends mainly on the volume of the active materials contained in their electrodes. Therefore, to obtain batteries with an acceptable capacitance, there must be either a greater number of electrodes or the electrodes must have larger surface areas.

These considerations led the designers to manufacture storage batteries in the form of stacks or compact coils.

The difficulty in assembling elements of this sort is obtaining satisfactory electrical connections with the output terminals.

Connections of this type have to be numerous and well distributed enough to give the electrical current delivered or supplied a large enough area of passage at all points of the electrodes. The method usually used to solve this problem is to have metal tabs welded onto

different electrodes or as part of the base, as well distributed as possible, and to weld them together by the free ends of these tabs for all electrodes that have the same polarity. The ends of the group of tabs belonging to electrodes of the same polarity and welded in this way are then connected to the corresponding current output terminal.

Such a method obviously presents some rather considerable difficulties in terms of manufacture without necessarily ensuring a sufficient connection cross-section. Moreover, this process is costly and its use results in a considerable amount of energy being lost through the Joule effect.

The method for configuring the electrical connections of electrodes and their connections to the current output terminals as claimed in the invention eliminates these disadvantages. The distinctive feature of the method is that it consists of several current collection zones distributed over the conductive sections of one or more electrodes with a specific polarity and situated on the edge of this electrode or these electrodes, joining or connecting these zones to a roughly flat conduction element applied to the aforementioned edge of the electrode or electrodes and connecting this flat element to the corresponding current output terminal.

According to another characteristic of the invention, welding, brazing or a similar process is used to create the connection between the aforementioned flat element and the current collection zones situated on the edge of the electrode or electrodes.

According to yet another characteristic of the invention, the number of current collection zones as well as the dimensions of the aforementioned flat element and contact sections between it and the electrode or electrodes are selected based on the planned maximum discharge current intensity of the storage battery or cell.

According to another characteristic of the invention, the electrode or electrodes having a single polarity or both polarities have borders near their respective edges on which currents are sampled, exposing the conductive metallic base of said electrodes.

According to yet another characteristic of the invention, in which the aforementioned connection between the flat element and the edge of the electrode or electrodes with the same polarity is created by electrical welding, the anode, for example, or mass of the weld unit is connected to the aforementioned exposed conductive border while the cathode of the weld unit is applied to the surface of the flat element which is not associated with the edge under consideration, allowing spot welding or line welding to be done between the aforementioned edge and the flat element.

According to yet another characteristic of the invention, the electrode packet capped at its ends with flat elements and current output terminals is mounted in a protective jacket using an insulator which fits into grooves or ribs formed on the periphery of the terminals.

According to yet another characteristic of the invention, the aforementioned insulator is for example made of a mixture of pitch and epoxy resin added before the end of polymerization.

According to another characteristic of the invention, the aforementioned outer protective jacket is closed on both its ends by a perforated cover which has a central tube surrounding the aforementioned grooves and which is crimped onto the aforementioned insulator.

It is immediately obvious that the main advantage of the new method is that it allows current to be sampled at multiple points and over areas as large as desired, while at the same time simplifying construction.

The invention is also aimed at electric storage batteries or electrolytic cells obtained using the method of configuration cited above, characterized in that at each end of the packet composed of two or more electrodes with opposite polarities it has a flat shaped element applied to the edge of one or more electrodes of a given polarity, and connected electrically in a number of zones to this edge, said flat elements being connected to the corresponding current output terminals.

According to yet another characteristic of the invention, and according to one form of embodiment, the electrode packet comprises a coil of two electrodes or strips of opposite polarities with their separators, the aforementioned flat elements then having a roughly circular contour.

According to another characteristic of the invention, the positive strip and the negative strip forming the aforementioned coil, have an equivalent height, measured parallel to the coil axis, and are staggered in such a way that only edges of a single polarity appear at each end of the coil.

Other characteristics of the invention will appear in the description below.

The attached diagrams show the following only by way of example:

Figure 1 shows a perspective view of an example of application of the method according to the invention for a coil of electrodes;

Figure 2 shows a detailed cutaway view on a larger scale showing a sample layout of layers of electrodes separated by separators;

Figures 3 and 4 show one phase of construction of a storage battery or electrolytic cell as claimed in invention;

Figure 5 is a detailed view on a larger scale showing the shape of several outer layers of the coil after the construction phase shown in Figs. 3 and 4 has been completed;

Figure 6 shows an example of distribution of the weld lines on a flat element welded on a coil of electrodes as claimed in the invention;

Figures 7 and 8 show other phases of construction;

Figure 9 shows a bottom view of a flat element as claimed in the invention;

Figure 10 shows in a detailed cutaway view on a larger scale one version of the electrode used as claimed in the invention;

Figure 11 is a diagram showing use of an electrode as per Fig. 10;

Figure 12 shows a perspective view of an electrode packet comprising a stack of plates laid out according to the invention;

Figure 13 shows a phase of construction of a storage battery formed by a stack of electrodes as claimed in the invention;

Figure 14 is a longitudinal cutaway view of a storage battery as claimed in the invention;

Figure 15 is a Cartesian plane comparing the functions of a current-type electric storage battery and a storage battery as claimed in the invention;

The embodiment shown in Figs. 1 and 2 is an electrode packet 1, comprising, for example, a coil of two strips of electrodes, negative 2 and positive 3, separated by their separators 4 and 4'.

On edges 5 and 6 of said packet 1, flat elements 7 and 8 are applied which have a contour that roughly matches the contour of said edges.

The flat elements 7 and 8 are connected electrically to these edges in as many areas as desired. They can even be attached over the entire extension of these edges.

The connection between the flat elements and the edges of the electrode packet is made by electrical welding, for example. It is nonetheless obvious that this connection can be made by any other appropriate means, including thermal welding, brazing, etc.

What is important is to increase the number and the surface area of the contact zones between the edges of the electrodes and the aforementioned flat elements.

Figure 2 shows on a larger scale how the edges of an electrode packet as claimed in the invention can be arranged.

This figure shows three negative electrodes comprised of a metallic base 9 with good conductivity, coated, for example, on either side with active layers 10.

There are also two positive electrodes, also comprised of a metallic base 11 with good conductivity and also coated on either side with active material 12.

Separators 13 are interspersed between the electrodes of opposite polarity.

It can be observed that the negative and positive electrodes have been staggered in relation to one another. In this way, only the edges 5 or 6 of the electrodes with the same polarity protrude

beyond the end of the electrode packet.

In addition, each end of the electrodes has been stripped to these edges. Thus, in this place, only the respective metallic bases 9 or 11 are visible along the length of the border 9a or 11a.

Under these circumstances, the aforementioned flat elements 7 and 8 are applied directly to the edges of these supports.

Of course, when the electrodes are relatively good conductors, particularly in the case of negative electrodes, it may not be necessary to strip the metallic support.

Figure 3 shows how, according to one form of embodiment of the invention, the flat element 7 is welded to the edge of one of the ends of the coil 1, as mentioned above.

In this figure, the cathode 14 and the anode or mass 15 of a weld unit can be observed. It is evident that cathode 14 of said weld unit is in contact with the external surface of flat element 7, while the anode or mass of the weld unit 15 is in contact with the external edge of the exposed border 11a.

An embodiment such as this one allows spot or line welding, resistance seam welding, for example, of flat element 7 on the edge of the electrode packet. This type of welding obviously has an enormous advantage in comparison with previous forms of embodiment, which used tabs. In the embodiments as claimed in the invention, the current is drained over almost the entire length of the edges of the electrodes; consequently, the cross-section of flat element 7 can be chosen as desired, and in particular to be large enough that barely any drop in voltage will occur during passage of the current.

Figure 4 shows on a larger scale an embodiment of a clamp forming an anode or mass of the weld unit as mentioned previously and can be used in particular when the electrode packet comprises a coil.

This anode 15 can for example be composed of a double clamp 16 hinged around a pin 17. At the end of the clamp opposite its hinge pin 17 the latter has for example two insulating handles 18, making it very practical to use. A spring or similar element 19 can be used to open the clamp, thus facilitating its placement around the aforementioned border 11a. Projections 20 and depressions 21 can for example be fashioned on the internal jaws of the clamp 16. These projections and depressions thus enable good electrical contact between the coil of the border 11a and said clamp. A fixed stop 22 and a stop 23, adjustable using an adjusting screw 24, allow, for example, a range of choices in clamping the coils. In particular, in the example shown, it can be observed that clamping has crimped the three external spires of the coil belonging to border 11a, which will then be welded in this position to flat element 7 which will be positioned on said coil.

Of course, the role of the cathode and anode of the weld unit could be reversed, with the cathode having the shape of a clamp as cited above and the anode being connected to the aforementioned coil.

Figure 5 shows on a larger scale the approximate shape of the external border 9a, which has been crimped by a clamp similar to the one shown in Fig. 4. Solid lines mark the coils that have been layered with an internal projection 20 of the clamp 16. In 25 and 26 dotted lines show the forms taken by the outer border 11a in contact with the bottom of an internal depression 21 of the clamp 16, and in an intermediate position between a depression 21 and a projection 20 of said clamp, respectively. In this latter case, it can be observed that the coil, and in particular border 11a belonging to said coil, are not crimped.

Figure 6 shows how, for example, to make the welds connecting the flat element 7 to an edge of an electrode packet. In the event that this electrode packet is a coil, it can be observed that the weld lines 27 are roughly radial in direction and therefore roughly perpendicular to the coils at each weld point. Of course, these weld zones can be arranged differently, but preferably in a regular fashion.

Figure 7 shows how a next phase in construction of a storage battery or electrolytic cell can be carried out as claimed in the invention. Flat element 8 is welded onto the coil edge opposite the one that already has flat element 7 on it. In this case, the mass of the weld unit 15 can simply be applied to the periphery of electrode packet 1. In fact, one or more negative electrodes used in the construction of the electrical element will usually be found on the periphery of the packet. These electrodes are usually a fairly good electrical conductor, and it is not always necessary here to have a wide exposed border, which is comprised of the support of the negative electrodes itself. In certain embodiments, this exposed border, which was shown on a larger scale in Fig. 2 as 9a, can be simply omitted as mentioned above. In this case, at the base of the coil or stack of electrodes, all that needs to project is a small border comprising the negative electrode by itself.

Figure 8 shows the last phase of construction. This figure shows a coil of electrodes 1 capped at each ends with flat elements 7 and 8. This assembly is then placed in its protective jacket 28, and an insulator 29 caps the flat element 7, and on top of the latter, the current output terminal 30. A cover 31 has a shoulder 32 which fits into the protective jacket 28. This shoulder 32 can for example be welded onto the jacket 28. The cover 31 also has a central tube 33. Between the current output terminal 30 and the tube 33 there is an electrical insulator 34, which is fairly malleable. This electrical insulator can, for example, be made of a mixture of pitch and epoxy resin added before polymerization of the resin is complete. Subsequently, when the passage 33 is crimped on the soft insulator 34, the latter fills grooves 35, which have been fashioned on the terminal 30. Good cohesion is thereby ensured between said terminal and said passage and subsequently - when the insulator 34 hardens - it firmly sets the terminal 30 in position on the protective jacket 28. A later overall view will show how this crimping is accomplished.

The flat element 7 and the terminal 30 were shown here all in one piece. The flat element and its terminal can be forced, molded or machined together using any other appropriate process.

In this case the example will be roughly in the shape of a mushroom. Thus the intensity of the current delivered or supplied by or to the storage battery is roughly constant at each point of the flat element and of the current output terminal. Of course, the surface area of the straight section of the mushroom will be determined based on the maximum intensity of the electrical

current passing through the particular storage battery or electrolytic cell.

For similar reasons in the case where the electrical terminal is connected to the flat element, by welding for example, giving the base of said terminal connected to the flat element a flared shape would be advantageous.

In Fig. 9, the bottom view shows the flat element 8 equipped with its current output terminal 36. This figure shows that this flat element 8 has holes 37, of which there can be two, for example. The role of these holes is to allow the electrode jacket contained in its protective jacket to be filled with electrolyte. To carry out this filling, all that is needed is to position the electrode packet surrounded by its protective jacket and hermetically sealed on its end corresponding to the current output terminal 30 (after crimping the tube 33 and hardening the insulator 34) in such a way that the packet made in this way has terminal 30 at the bottom and terminal 36 at the top. The electrolyte is then fed through one or more of the holes 37 while at least one of these holes allows the corresponding amount of air to escape. Filling in a vacuum can be advantageous.

Subsequently, and still in this position, an insulating washer 38 and cover 39 will be placed on terminal 36. This cover is welded, for example, by its edges 40 onto the jacket 28. It has a central tube 42. A soft insulator 34 is then fed through terminal 36 having grooves 41 and tube 42 of covering cap 39, said passage being crimped under the same conditions as tube 33 as was explained earlier (see Fig. 8).

The storage battery or electrolytic cell obtained in this manner is then perfectly tight, compact and hermetically sealed.

Of course, if a sealed battery is not wanted, it is sufficient, for example, to provide appropriate openings, possibly equipped with valves, in the protective jacket 28 (not shown) without modifying the design principle.

Figure 10 shows on a larger scale an electrode fragment 43 exposing a border 44 belonging to the conductive metallic base of the electrode. In this example, the two surfaces of the electrode's metallic base 45 are coated with an active material. This figure also shows narrow slits 46, V- or U-shaped for example, the axis of which is roughly parallel to the main direction of the electrode packet.

Figure 11 shows how it would be possible, for example, to weld together the outer spires of a coil comprising an electrode packet when these electrodes have narrow slits 46 on their border 44. Of course, these slits 46 can be made all along the border of one or more electrodes or, in particular, along the length of only two or three outer spires of a coil. If these electrodes are used, the clamp shown in Fig. 4 forming the mass of the weld unit can have an internal surface that is essentially cylindrical.

Figure 12 shows an electrode packet 47 comprising a stack of alternate layers of negative electrodes 48 and positive electrodes 49 separated by separators 50.

On edges 51 and 52 of said packet 47 flat elements 53 and 54 are applied, the contour of

which corresponds approximately to that of said edges.

Current output terminals 55 and 56 are joined to said flat elements, respectively, using welding, brazing, etc., or are produced as one piece with the elements.

These terminals can also comprise grooves 57 and 58.

Construction of a storage battery from this electrode packet capped with two elements as cited above is the same as that described above for an electrode packet composed of a coil.

Obviously the shape of the anode clamp of the weld unit mentioned above will be slightly different.

Figure 13 shows this particular form. Clamp 59 in this case has an internal shape with approximately the same as the shape as the longitudinal edges 60 of the stack of electrodes being manufactured. The hinge pin 61 of the two jaws of the clamp can then advantageously assume a number of positions fashioned in a type of notched rack 62 to allow use of the same clamp to make stacks with varying dimensions. The internal walls 59' of the clamp 59, which clamps the edges 60 of the stack, can advantageously have small ribs allowing good electrical contact between said clamp and the electrode packet.

Figure 14 shows a general pulled-out cutaway view of a storage battery or electrolytic cell as claimed in the invention.

This storage battery 63 essentially comprises a stack or coil of electrodes plates, positive 64 and negative 65, respectively, separated by separators 66. Obviously these different electrode strips and their separators are impregnated with an electrolyte (not shown). Said electrodes, positive 64 and negative 65, respectively, are joined as claimed in the invention by their respective edges 67 and 68 to the two corresponding flat elements 69 and 70. The latter are themselves connected to the current output terminals 71 and 72. Said terminals 71 and 72 have any appropriate device electrically connecting them to an outside circuit, such as for example sets of two nuts and a washer shown as 73 and 74 and can clamp the lug of an electrical connection cable for example (not shown). The flat metal elements 69 and 70 capped with their terminals 71 and 72 have grooves 77 and 78. Two caps 79 and 80, made of metal, for example, close off the two ends of element 63. In the example shown these caps 79 and 80 have central tubes 81 and 82, respectively, crimped onto an electrical insulator 83. This electric insulator can, for example, be made of a mixture of pitch and epoxy resin, which ensures perfect cohesion between the grooved current output terminal and the central tub of the metal cap after crimping, as explained above. These caps 79 and 80 have edges 84 and 85 on their periphery allowing good adhesion between said edges and the outer protective jacket 86 of element 63.

In addition to the considerable advantages obtained in the construction of these elements, the latter also have superior electrical output.

Figure 15 shows, by way of example, the comparative discharge curves at 5C, C being the nominal capacitance in ampere-hours for the two storage batteries examined. Curve I is the

discharge curve of a storage battery manufactured as claimed in the invention, while curve II is the discharge curve of a storage battery of known type where the connections between the terminals and the electrodes are obtained with welded tabs.

These curves were plotted on a Cartesian plane with the voltages or potential differences plotted on the y-axis in volts and the amounts of current measured on the x-axis in ampere-hours. The y-axis at left shows the potential differences on the terminals of an element, while on the right are the potential differences on the terminals of five elements arranged in a series.

It can be observed that the electrical power available under these operating conditions is much higher with the storage batteries having the connections configured as claimed in the invention. The electrical power therefore is as follows: V.I.*t*. (V in volts, I in amperes, t in time); it can be immediately observed in Fig. 15 that the electrical power available with a current-type storage battery with a discharge curve being curve II is shown by the area between this curve and the semi-axes OX and OY.

Likewise, the electrical power available with a storage battery as claimed in the invention, with discharge curve being curve I, is shown by the area between this curve and semi-axes OX and OY.

For the same amount of current delivered (3 Amp/hr for example), the electrical power available with a storage battery having connections configured as per the invention is shown by the cross-hatched area between curve I, axes OX and OY, and the line parallel to axis OY and passing through the x-axis: 3 Amp/hr, while the electrical power available with a storage battery of the current type is shown by the cross-hatched area between curve II, axes OX and OY, and the line parallel to axis OY and of x-axis 3 Amp/hr.

A number of modifications can be made to the forms of embodiment described and represented herein without departing from the framework of the invention. So in particular any appropriate method can be used for welding or connecting in any other way the flat element as claimed in the invention onto the edges of the electrodes.

Of course, the invention is not in any way limited to the forms of embodiment described and represented here, which are given only by way of example.

CLAIMS

The object of the invention is as follows:

I. A method for configuring the electrical connections of electrodes in electrolytic cells and storage batteries, and connecting them to current output terminals, having the following unique characteristics, taken separately or in combination:

a. There are several current collection zones distributed over conductive sections of one or more electrodes having a given polarity and situated on the edge of this electrode or of these electrodes, joining or connecting these zones to a conductive element with a roughly flat shape,

applied to the aforementioned edges of the electrode or electrodes and connecting said flat element to the corresponding current output terminal;

b. Welding, brazing or a similar process is used to make the connection between the aforementioned flat element and the current collection zones situated on the edges of said electrode or electrodes;

c. There are two of the aforementioned flat elements per storage battery or per cell, one per polarity, each being located at one of the extremities of the packet that comprises two or more electrodes with opposite polarities;

d. The number of current collection zones and dimensions of the aforementioned flat element, and the contact sections between it and the electrode(s), are chosen based on the maximum discharge current intensity of the storage battery or cell;

e. The electrodes of a single polarity or two polarities have, proximate to their respective edges, on which current is collected, borders which expose the conductive metallic base of said electrodes;

f. In the case in which the aforementioned connection between the flat element and the edge of the electrode or electrodes of a same polarity is created by electric welding, the anode for example or mass of the weld unit is connected to the aforementioned exposed conductive border, while the cathode of the weld unit is applied to the surface of the flat element not associated with the edge under consideration, allowing spot welding or line welding to be done between the edge and the aforementioned flat element;

g. The weld lines connecting the flat element to the aforementioned edge have directions roughly perpendicular to the surface of the electrode(s) under consideration at the weld points;

h. The anode or mass of the aforementioned weld unit comprises a clamp, elastic jaw or similar element, the internal form of which approximately matches that of the electrode packet;

i. The aforementioned clamp, elastic jaw or similar element has on its internal surface projections or undulations ensuring good electrical contact between it and the aforementioned border, at the same time somewhat crimping the border, or several borders, on the outside of the electrode packet, to allow them to be welded to one another.

j. According to one form of embodiment, a packet comprising two electrodes of opposite polarities with their separators wound in coils is formed, and at each end, on the edges of this coil, two of the aforementioned flat parts having a roughly circular shape are attached.

k. In this latter case, the aforementioned welding clamp is essentially circular in shape, while the weld lines are essentially radial;

l. The flat elements are connected to the output terminals and joined together with them;

m. The electrode packet capped at its ends with the flat elements and current output terminals is attached in a protective jacket using an insulator which fits into grooves or ribs formed on the periphery of the terminals;

n. The aforementioned insulator is for example composed of a mixture of pitch and epoxy resin, added before the end of polymerization;

o. The aforementioned outer protective jacket is closed at both its ends by a perforated cover having a central passage which surrounds the aforementioned grooves and which is crimped on the aforementioned insulator.

II. The electric storage batteries or electrolytic cells obtained using the aforementioned configuration method is unique in that it has the following characteristics, taken separately or in combination:

a. At each end of the packet comprising two or more electrodes of opposite polarities, there is a flat element applied to the edge of one or more electrodes of a given polarity and electrically connected in several areas to this edge, said flat elements being connected to the corresponding current output terminals;

b. The electrode or electrodes having one or two polarities have, on at least one of their lateral sides and along the edges where current is collected, borders that are exposed to reveal the conductive metallic base;

c. The connection between the edge of the electrode(s) of a given polarity and the aforementioned corresponding flat element is formed by weld points or lines or the like;

d. According to one form of embodiment, the aforementioned weld lines have directions roughly perpendicular to the surface of the electrode(s) under consideration at the points of said weld lines;

e. According to one form of embodiment, the electrode packet comprises a coil of two electrodes or strips of opposite polarities with their separators, the aforementioned flat elements therefore having a roughly circular contour;

f. The coil cited above is made in such a way that the external strip corresponds to the negative electrode;

g. The positive strip and the negative strip forming the aforementioned coil have a height measured parallel to the coil axis which is equivalent and they are staggered in such a way that only the edges of one polarity appear at each of the coil's ends;

h. The edges of at least some of the strips proximate to the edges on which current is collected are crimped and welded together;

i. The strips to which the welded-together edges belong are located on the periphery of the

electrode packet;

j. According to one form of embodiment, there are narrow slits in the aforementioned borders and they have a direction essentially normal to the surface of the flat element applied to the edge under consideration, these slits being formed in at least one of the outer strips of the coil, thus making them easier to crimp so that they can be welded together;

k. A flat element has the shape of a disk or a thin plate having a shape essentially identical to that of the edge of the coil or of the packet to which it is attached;

l. The aforementioned flat element is attached to an output terminal or joined together with it, assuming the appearance of a mushroom;

m. The surface area of the straight section of the base of the mushroom has a value determined by the maximum intensity of the collected current;

n. According to one form of embodiment, the output terminals are hollowed out at their base and are connected at this site by welding for example to the aforementioned flat elements;

o. The aforementioned terminals, of a cylindrical shape for example, have external grooves or ribs situated in planes roughly perpendicular to their axis or to their generatrices;

p. According to one form of embodiment, the aforementioned flat element, topped with its current output terminal and connected to the corresponding positive or negative strip, placed in its protective insulated jacket, is topped with an insulating washer or the like which is perforated with a hole to allow passage of said terminal, then with a metal disk forming a cover piece capping the aforementioned insulating washer, this metallic disk having a central passage to allow the terminal to go through it;

q. The output terminal and the central passage of the aforementioned metal disk are insulated by insertion of an electrical insulator;

r. The aforementioned electrical insulator comprises for example a mixture of pitch and epoxy resin, and is added before the end of polymerization;

s. The aforementioned insulator fits into the aforementioned grooves or ribs;

t. The passage of the aforementioned cover is crimped onto the insulator;

u. One of the two aforementioned flat elements and preferably the one connected to the negative electrode is perforated with holes allowing electrolyte filling of the cell or storage battery preferably conducted in a vacuum, this filling being carried out when the cell or storage battery is hermetically sealed at its other end.

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